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Fourth Quarter 2023 Landfill Gas Sampling

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Dear Karma:

This letter reports landfill gas data collected at Terrace Heights Landfill, Cheyne Landfill, and the Lower Valley Transfer Station (LVTS) on December 5 and 6, 2023 (2023 Q4).

Summary

- *Methane concentrations exceeded 5% by volume (the lower explosive limit, LEL) at Terrace Heights in perimeter probes GP-4S (62.9%), GP-4M (41.5%), GP-4D (63.3%), and GP-11S (7.2%). Perimeter exceedances at Terrace Heights are consistent with previous exceedances and are being addressed by Yakima County. Methane concentrations exceeded the LEL at Terrace Heights southern boundary probe GP-2S (28.1%).*
- *Methane concentrations exceeded the LEL at Cheyne Landfill at interior probes GP-2D (10.9%), GP-3S (15.0%), and GP-3D (34.1%). Methane concentrations also exceed the LEL in perimeter gas probes GP-8-1 (44.5%) and GP-8-2 (26.7%) this quarter.*
- *Methane concentrations did not exceed the LEL in the perimeter gas probes at Lower Valley Transfer Station.*

Landfill Gas Results

All gas probes sampled by Mott MacDonald were purged with a portable hand pump immediately prior to sampling. The purge volume was a minimum of three times the casing volume. Each probe was sampled for methane, oxygen, and carbon dioxide volume percent using a Landtec GEM 2000 gas meter.

Terrace Heights Landfill

Landfill gas monitoring at Terrace Heights includes 25 probes in 11 separate monuments (Figure 1, Table 1), 22 of which are monitored quarterly. The 22 gas

probes were measured on December 6, 2023 (Figures 2 and 3). Key results include:

- Methane was detected below the LEL in perimeter probes GP-11M (0.0%), GP-11D (0.0%), GP-10 (0.0%), and GP-9 (0.0%).
- Methane was detected above the LEL in perimeter probes GP-4S (62.9%), GP-4M (41.5%), GP-4D (63.3%), and GP-11S (7.2%) and in southern boundary probe GP-2S (28.1%).

Figure 2 shows the methane concentrations in all probes installed prior to 2003 in which methane has been detected. The spike in the June 2000 sampling event may or may not be real. Regardless of the spike, methane was present above LEL along the southern boundary of the landfill from 1995 through August 2005. Methane was detected above the southern boundary at GP-2S (28.1%) during this sampling event. Yakima County moved to daily monitoring along southern gas probes and is evaluating the existing southern gas control system. A Remedial Action Plan was submitted to the Yakima Health District on March 1, 2024.

Twelve gas extraction wells at six separate locations were installed at Terrace Heights in October 2003 (Figure 1). Gas extraction commenced on April 6, 2005. Measurements taken immediately after the gas extraction system was started showed consistently high levels of methane at all well heads. Decreases in methane concentration in gas probes along the southern property line are consistent with removal of methane from the landfill via the gas extraction system. The continued decline in methane concentrations from April 2005 through December 2006 and levels below the LEL from December 2006 through June, 2008 indicate that the gas extraction system has been effective at reducing subsurface methane levels along the southern property boundary. In response to this decline, Yakima Health District approved a request to discontinue quarterly monitoring at GP-6 and GP-7[1] (YHD, 2011). Three additional monitoring probes were completed on November 5, 2010 at locations GP-9, GP-10 and GP-11 to improve monitoring around the perimeter of the facility (Figure 1). Each location has a shallow, middle, and deep monitoring interval.

Methane concentrations were increasing at GP-11S from 2011 through 2017. Methane at GP-11S (7.2%) exceeded the LEL in the December 2023 sampling event (Table 1). Though concentrations have stabilized below their peak, methane is routinely detected in the GP-11S, GP-11M and GP-11D intervals near the LEL.

Concentrations at GP-4 have varied above and below the LEL several times since 1996, with an overall increasing trend for GP-4M and GP-4D; Methane at GP-4S (62.9%), GP-4M (41.5%), and GP-4D (63.3%) exceeded the LEL in the December 2023 sampling event (Figure 3, Table 1). A pattern of historic detections at GP-4 probes indicates that the landfill gas extraction system along the southern portion of the landfill is not significantly influencing methane concentrations in the northern portion of the landfill. Yakima County installed passive gas vents GV-1 through GV-6 in January 2012 to mitigate landfill gas migration at the northern property boundary (Figure 1).

Continued exceedances along the northern landfill boundary indicate that the passive vent system has not mitigated LFG migration at the northern boundary.

[1] Quarterly monitoring will resume at GP-6 and GP-7 if methane is detected above 2.5% at any of the GP-3 probes or if the gas extraction system is shut down for a month or more.

Yakima County is currently developing a mitigation approach to address LFG migration at the northern property boundary that is consistent with broader landfill gas control objectives at Terrace Heights.

Cheyne Landfill

Monitoring at Cheyne Landfill includes 16 probes in 8 separate monuments (Figure 4). Three additional probes were added in July 2007, shown on Figure 4 as GP-6, GP-7, and GP-8. GP-6-1[2], GP-6-2, GP-7-1, GP-7-2 are included in the current monitoring program, are measured annually, and have not had any detections of methane to date (Table 2). Probes were monitored on December 5 and 6, 2023 (Figures 4 and 5). Key results include:

- Methane was detected below the LEL in perimeter probes at values up to 2.9%.
- Methane was detected above the LEL in interior area probes GP-2D (10.9%), GP-3S (15.0%), GP-3D (34.1%), GP-8-1 (44.5%), and GP-8-2 (26.7%).

Detections above LEL at perimeter gas probes GP-8-1 and GP-8-2 in March 2012 were the first exceedances at those gas probes. Yakima County submitted a Remediation Plan to Yakima County Health to address subsurface methane near GP-8, which was approved on July 31, 2012. Methane exceeded the in GP-8-1 and GP-8-2 LEL again in June 2015 and Yakima County began collection of verification samples according to the Remediation Plan. Verification sampling was concluded on September 29, 2015 with a conclusion that the verification sampling had confirmed exceedance according to the criteria outlined in the Remediation Plan. Yakima County notified the Health District of the confirmation of exceedance in an email dated October 15, 2015 and is pursuing a plan to address the exceedances in communication with the Health District.

The plot of methane concentrations at Cheyne (Figure 5) suggests that levels above the LEL have been present in the landfill since the late 1990s. A large methane spike was detected in the June 2000 sampling event, as was the case at Terrace Heights. Again, the accuracy of the spike is difficult to assess. Regardless of the spike, the methane concentrations in GP-3D and GP-3S appear to have risen above and fallen below the LEL several times since 2002 and have been gradually increasing over time. The temporal pattern of concentrations at GP-3S is similar to GP-3D, but generally at lower concentrations.

Lower Valley Transfer Station

Six gas probes (in three separate monuments), 10 wells in the passive gas collection system, and a flare are sampled quarterly at the Lower Valley Transfer Station (LVTS) (Figure 6, Table 3). Probes were monitored on December 5 and 6, 2023. Key results include:

- Methane was detected above the LEL in passive collection wells, GW-4 (8.2%), GW-5 (10.4%), GW-7 (19.7%), GW-8 (24.7%), GW-9 (20.1%), and GW-10 (44.3%).

[2] These gas probes use a different naming system where GP-6-1 and GP-6-2 indicate the shallow and middle screened intervals, respectively. The -1 and -2 suffixes refer to the port numbers on the top of the Solinst CMT casing.

The flare igniter was not clearly audible prior to sampling. Methane was not detected above the LEL at the flare (0.0%).

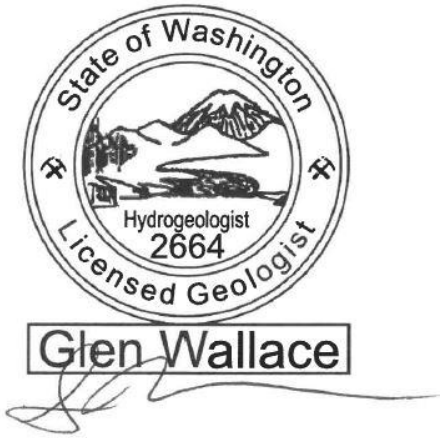
Continued Sampling

Gas monitoring probes at Terrace Heights, Cheyne and LVTS, as well as the passive collection and the flare at LVTS will be sampled again in February 2024.

We trust this information meets your needs. Please feel free to call if you have questions.

Respectfully Submitted,

Mott MacDonald



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Attachments:

Table 1	Landfill Gas Monitoring Data, Terrace Heights
Table 2	Landfill Gas Monitoring Data, Cheyne
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Figure 2	Methane Concentrations at Terrace Heights Southern Boundary Gas Probes
Figure 3	Methane Concentrations at Terrace Heights Perimeter Gas Probes
Figure 4	Cheyne Road Landfill Detailed Site Plan
Figure 5	Methane in Cheyne Gas Probes
Figure 6	Lower Valley Transfer Station Site Map

References:

Yakima Health District, 2011. Letter from Ted Silvestri to Wendy Mifflin, Re: Request to Change LFG Monitoring at Terrace Heights Landfill. February 17, 2011.

Table 1. Landfill Gas Monitoring Data, Terrace Heights Landfill

2023 Q4

Probe	Date	Time	CH4 (% total)	CO2 (% total)	O2 (% total)
GP-1S	12/6/2023	16:24	0.1	1.9	9.0
GP-2S	12/6/2023	16:15	**28.1**	12.1	0.0
GP-2D	12/6/2023	16:17	0	5	5.2
GP-3S	12/6/2023	15:16	0	1.2	15.3
GP-3M	12/6/2023	15:18	0	1.8	17.2
GP-3D	12/6/2023	15:20	0	2.5	17.7
GP-4S	12/6/2023	12:32	**62.9**	21.2	0.0
GP-4M	12/6/2023	12:34	**41.5**	19.1	1.5
GP-4D	12/6/2023	12:36	**63.3**	19.8	0.0
GP-5M	12/6/2023	16:01	0	2.1	19.5
GP-5D	12/6/2023	16:03	0	0.9	19.9
GP-8M	12/6/2023	16:28	0	2.2	14.3
GP-8D	12/6/2023	16:30	0	1.5	15.4
GP-9S	12/6/2023	13:41	0	0.8	20.3
GP-9M	12/6/2023	13:43	0	0.1	21.0
GP-9D	12/6/2023	13:45	0	0.1	21.1
GP-10S	12/6/2023	14:58	0	0.1	21.0
GP-10M	12/6/2023	15:00	0	0.3	20.9
GP-10D	12/6/2023	15:02	0	0.3	20.9
GP-11S	12/6/2023	12:23	**7.2**	22.8	0.0
GP-11M	12/6/2023	12:25	0	7.6	6.3
GP-11D	12/6/2023	12:27	0	0.7	17.2

Bold indicates value above LEL (5% by volume)

Barometric Pressure was 27.87 inches of water and increasing on 12/06/2023.

Table 2. Landfill Gas Monitoring Data, Cheyne Landfill

2023 Q4

Probe	Date	Time	CH4 (% total)	CO2 (% total)	O2 (% total)
GP-1S	12/6/2023	6:58:00 AM	0.1	5.3	13.6
GP-1D	12/6/2023	7:00:00 AM	2.9	11.5	0
GP-2S	12/5/2023	3:30:00 PM	0	14.8	4.3
GP-2D	12/5/2023	3:32:00 PM	**10.9**	6.3	1.2
GP-3S	12/5/2023	3:40:00 PM	**15**	29.2	0.2
GP-3D	12/5/2023	3:42:00 PM	**34.1**	33.5	0
GP-4S	12/6/2023	6:48:00 AM	0.1	0.2	21.1
GP-4D	12/6/2023	6:50:00 AM	0.1	0.2	21.1
GP-5S	12/6/2023	6:39:00 AM	0.1	0.2	20.7
GP-5D	12/6/2023	6:41:00 AM	0.1	0.1	20.8
GP-8-1	12/6/2023	9:10:00 AM	**44.5**	34.4	0.2
GP-8-2	12/6/2023	9:12:00 AM	**26.7**	19.6	1.1

Bold indicates value above LEL

Barometric Pressure was 28.68 inches of water and steady on 12/05/2023 and 28.59 inches of water and decreasing on 12/06/2023.

Table 3. Landfill Gas Monitoring Data, Lower Valley Transfer Station

2023 Q4

Probe	Date	Time	CH4 (% total)	CO2 (% total)	O2 (% total)
GP-1S	12/5/2023	11:42:00 AM	0	5.1	16.7
GP-1D	12/5/2023	11:44:00 AM	0	9.4	13.6
GP-2S	12/5/2023	9:10:00 AM	0	0.2	21.1
GP-2D	12/5/2023	9:12:00 AM	0	0.3	20.9
GP-3S	12/6/2023	8:40:00 AM	0.1	7.8	13.3
GP-3D	12/6/2023	8:42:00 AM	0	10.6	10.3
Flare	12/5/2023	11:49:00 AM	0	0.1	21.2
GW-1	12/6/2023	8:09:00 AM	0.1	18.7	1.2
GW-2	12/6/2023	8:12:00 AM	3.4	20.1	0.1
GW-3	12/6/2023	8:14:00 AM	2.1	8.4	12.7
GW-4	12/6/2023	8:17:00 AM	**8.2**	16.6	5.3
GW-5	12/6/2023	8:20:00 AM	**10.4**	20.2	3.1
GW-6	12/6/2023	8:06:00 AM	0.4	19.9	0
GW-7	12/6/2023	8:22:00 AM	**19.7**	24	2.5
GW-8	12/6/2023	8:31:00 AM	**24.7**	27.8	0
GW-9	12/6/2023	8:24:00 AM	**20.1**	23.9	1.9
GW-10	12/6/2023	8:28:00 AM	**44.3**	33.3	0

Bold indicates value above LEL

Barometric Pressure was 29.07 inches of water and decreasing on 12/05/2023 an 28.78 inches of water and steady on 12/06/2023.

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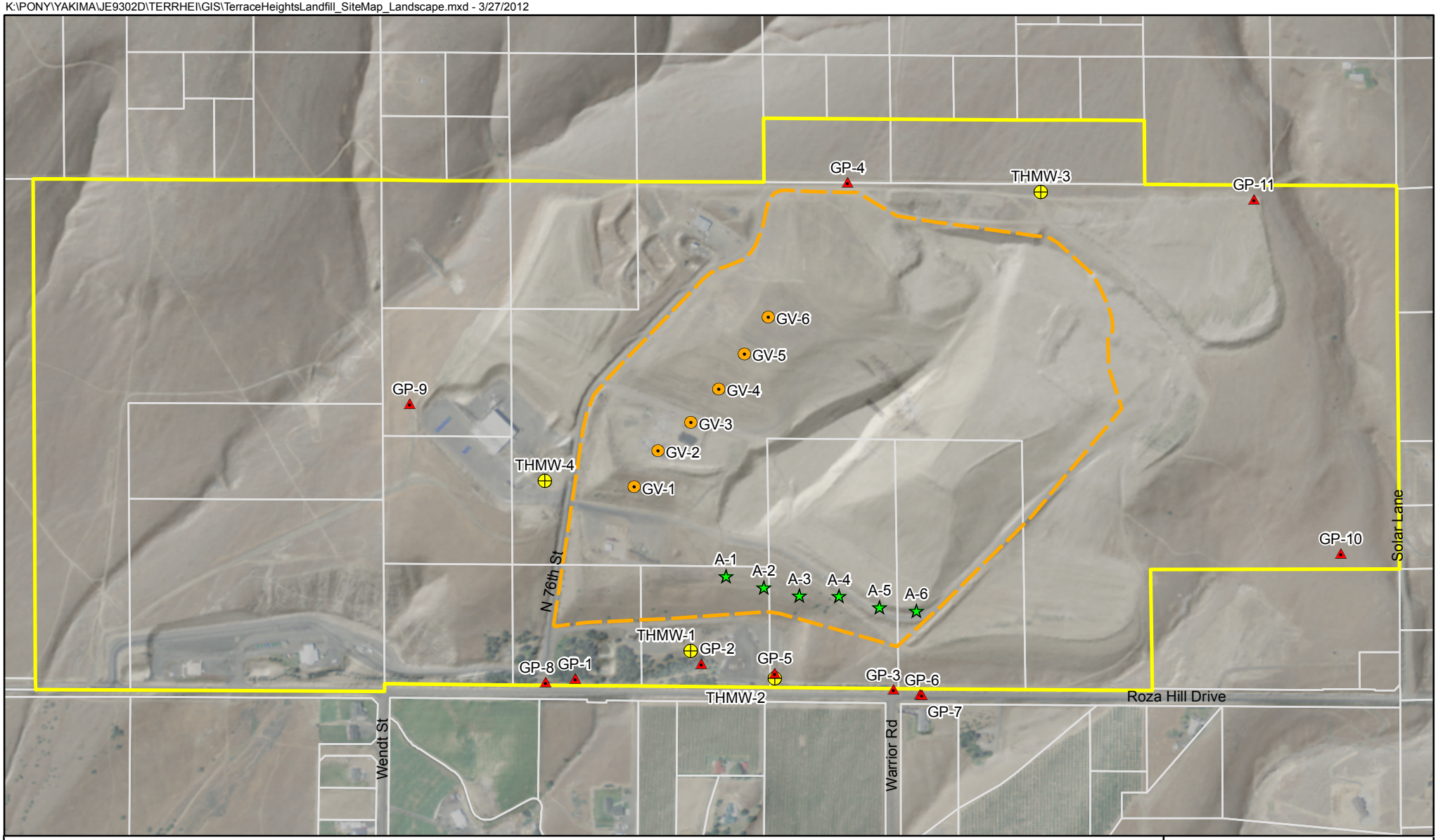


Landfill Boundary
Limit of Waste
Parcels

Existing Gas Probe
GW Monitoring Well
Gas Extraction Well
Gas Vent

N

0 Feet 700

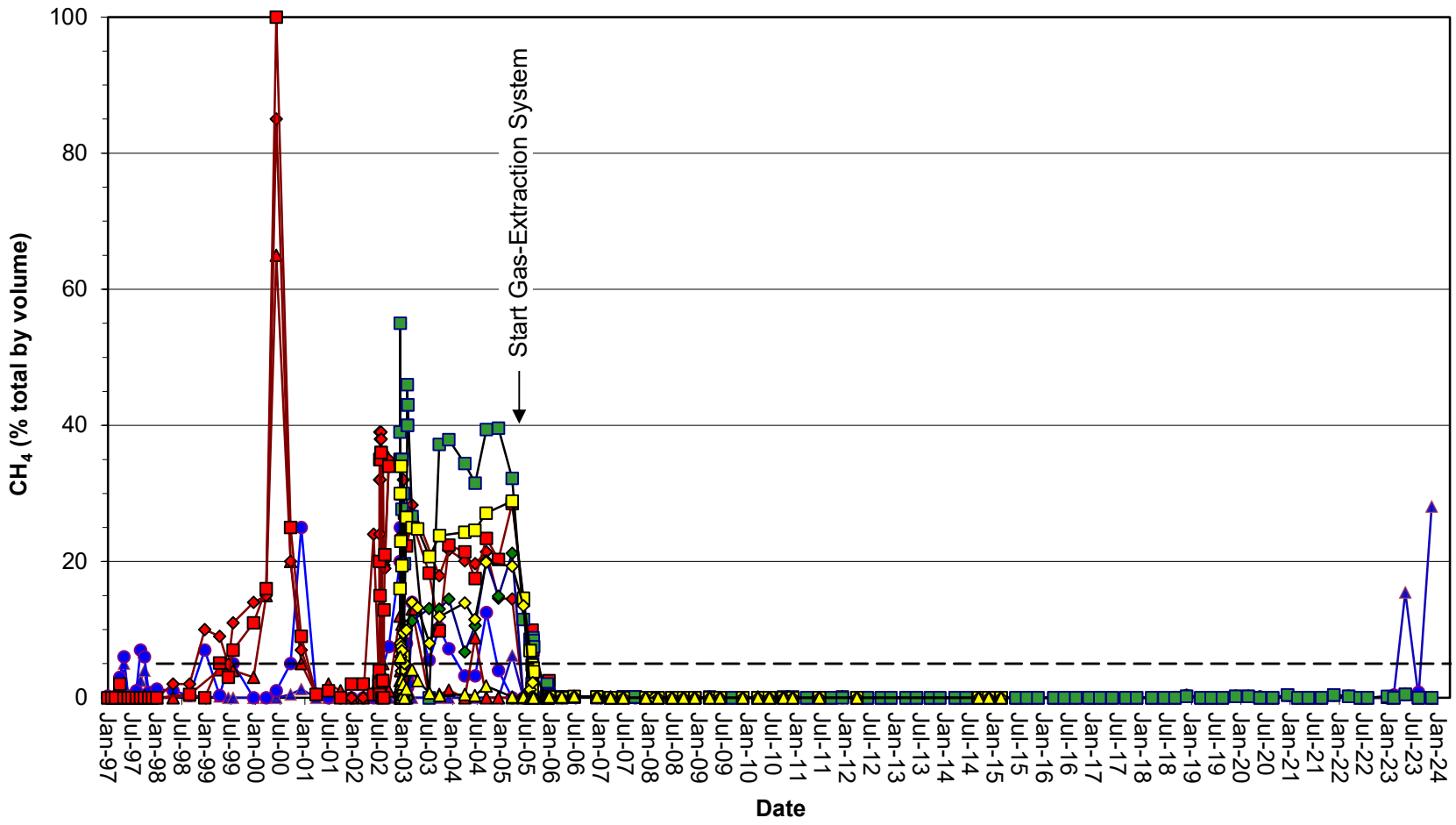
Figure 1

Terrace Heights Site Map

Terrace Heights Landfill
Yakima, WA

PgG

LiDAR from Puget Sound LiDAR Consortium (PSLC), 2003
Ortho from NRCS, 2009



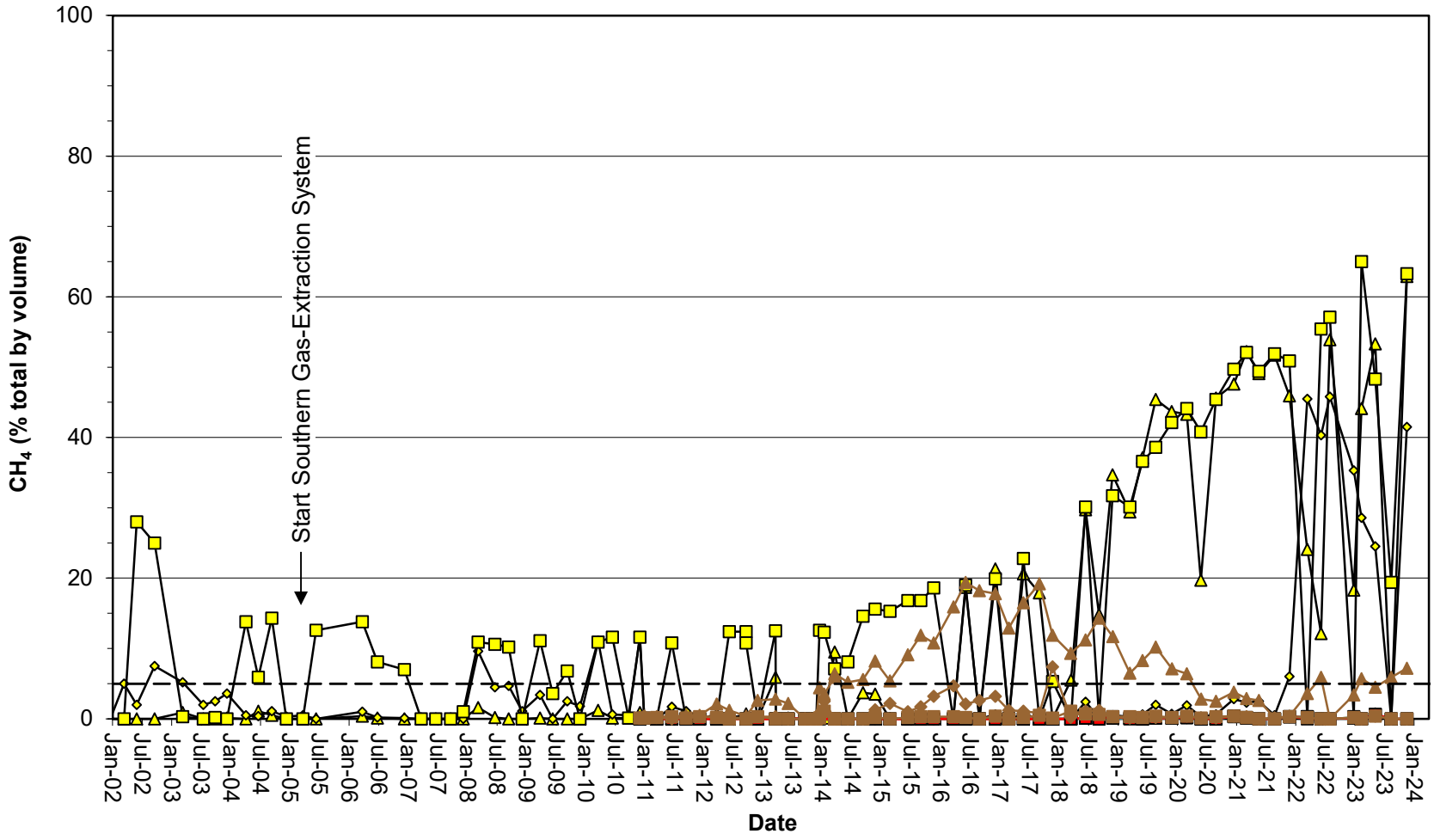
LEGEND:

GP-2S GP-2D GP-3S
GP-3M GP-3D GP-5M
GP-5D GP-6D GP-6M
GP-7S LEL

GP-1 and GP-8 data all < 1 %, not shown

Figure 2
Methane in Terrace Heights Southern Boundary Gas Probes

Terrace Heights



LEGEND:

GP-4S GP-4M GP-4D GP-9S
GP-9M GP-9D GP-10S GP-10M
GP-10D GP-11S GP-11M GP-11D
LEL

GP 9, GP-10 and GP-11 clusters completed 11/2010.

Figure 3
Methane in Terrace Heights
Perimeter Gas Probes

Terrace Heights

Gas Probe

Existing Wells

Property Boundary

Sections

Parcels

0 Feet 1,000

USDA Ortho 2006

N

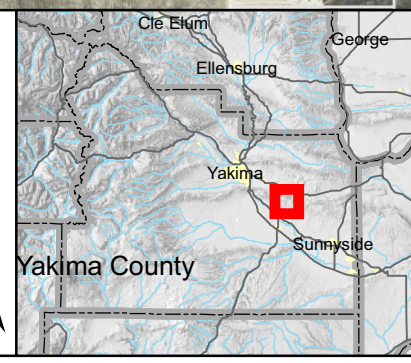
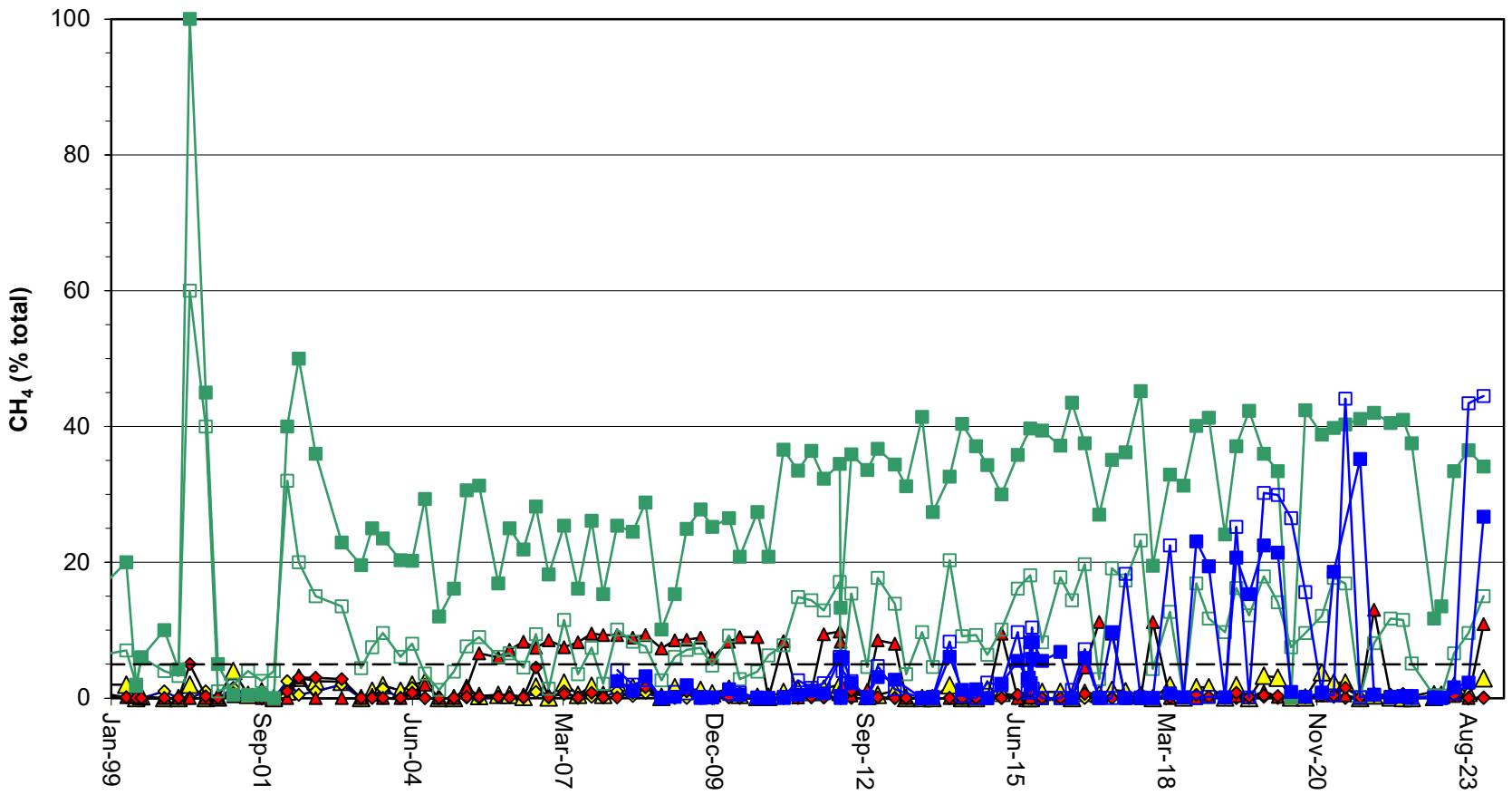


Figure 4
Cheyne Site Map

PgG



LEGEND:

- GP-1D
- GP-1S
- GP-2D
- GP-2S
- GP-3D
- GP-3S
- GP-8-2
- GP-8-1
- LEL

Figure 5
Methane in Cheyne Gas Probes

Cheyne Landfill

- Monitoring Well
- Gas Well
- Gas Probes
- Gas Extraction Piping
- Parcels (approximate)
- Extent of Waste (approximate)

N

0 Feet 400

1 inch equals 400 feet
2006 Orthophoto

Figure 6

Lower Valley Transfer Station
Site Map

PgG